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# Di-top mass reconstruction using advanced Machine Learning methods

In the Standard Model fermions obtain their masses ($m_f$) via the spontaneous symmetry breaking mechanism. To describe the coupling between Higgs and fermion fields a Yukawa coupling is introduced. The masses are then proportional to the vacuum expectation value of the Higgs field and the Yukawa coupling ($g_f = \sqrt{2}m_f/\nu, \nu = 246.22$ GeV). Since the top quark is the heaviest known fundamental fermion, the top-Higgs interaction provides an access to the largest Yukawa coupling.

We measure the top quark pair production cross section in the decay channel where one top decays fully hadronic and the other into a $b$-quark, a charged lepton and a neutrino. This cross section is affected by a virtual Higgs boson exchange between the two outgoing top quarks. The variable in this analysis, which is mostly sensitive to the Yukawa coupling, is the invariant mass of the top-quark pair. This mass is reconstructed from the measured decay products of the two top quarks, which contain a neutrino. Since we cannot fully reconstruct the neutrino momentum, this increases the difficulties to reconstruct the di-top invariant mass. There are several mass reconstruction techniques, among others a Machine Learning method.

The challenge is to choose an appropriate Machine Learning algorithm, train it using simulated data samples (supervised machine learning) and finally obtain the variable of interest - $m_{tt}$, from the real data, collected by the ATLAS detector at the LHC during 2015-2018 data taking period.

## Field

B1: Particle physics analysis (software-oriented)

## DESY Place

Zeuthen

## DESY Division

FH

## DESY Group

ATLAS_Z

## Special Qualifications:

- Knowledge of particle physics;
- Relativistic kinematics;
- Programming skills (C++, Python).

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